

Good Vibrations

Surface vibration provides useful information for products in a variety of industries. For example, automobile manufacturers measure surface vibrations to ascertain noise sources and to evaluate disk brake performance. Surface vibrations provide aircraft manufacturers with valuable information about the structural quality of panels, turbine blades, and critical aircraft body components. Musical instrument manufacturers measure the vibration of their instruments to confirm purity of sound.

A **Small Business Innovation Research (SBIR)** sponsorship from NASA's Dryden Flight Research Center, assisted MetroLaser, of Irvine, California, in the development of a self-aligned laser vibrometer system. VibroMet, capable of measuring surface vibrations in a variety of industries, provides information on the structural integrity and acoustical characteristics of manufactured products.

Currently, the most common device used to measure surface vibration is the accelerometer. Although useful in some aspects, accelerometers are generally time consuming and awkward to operate. In order to measure vibration, they must be attached to the surface of the subject and wired to a recording system. In some cases, this may actually dampen the vibration measurement. On the other hand, laser vibrometers provide a non-contact alternative to the accelerometer, eliminating the risk of an incorrect calculation.

MetroLaser's research and development of the vibrometer led to the VibroMet system, which analyzes the frequency and amplitude returned from the surface evaluation. This low-cost, easy-to-use sensor performs vibration measurement from distances of up to three meters without the need for adjustment. The laser beam is simply pointed at the target and the system then uses a compact laser diode to illuminate

the surface and to subsequently analyze the reflected light. The motion of the surface results in a Doppler shift that is measured with very high precision. The Doppler shift illustrates that sound waves have a fixed wavelength or distance between two crests. Simply explained, if a subject is moving away from the source, the sound wave will take a little longer to reach each crest, and a perceived longer wavelength will be heard. In contrast, if the subject is approaching the source, the soundwave will meet each crest a little earlier, and a shorter wavelength will be perceived.

Nicolet Instrument Technologies, of Madison, Wisconsin, uses the laser diode vibration sensor technology in its Orion Laser Doppler Vibrometer (LDV). The LDV is able to measure the smallest vibration without the need for scrupulous setup or surface preparation. The LDV can work on almost any surface and is capable of off-axis measurements. Because Nicolet's product is easy to use it is attractive to a variety of industries. Common uses of the company's product are rotating applications, such as automotive drive shafts, alternators, generators and tires; multi-point measurements in machinery and modal analysis; surface vibration measurements in small structures such as hearing aids, tissue membranes and micro-sensors; as well as applications in production testing, including hand tool assemblies, electric motors, and piezoelectrics.

The collaborative efforts of NASA and these companies have refined the laser vibrometer into a user-friendly, cost-effective surface vibration measurement system. VibroMet is considered one of the many behind-the-scenes tools that can be relied on to assure the quality, reliability and safety of everything from airplane panels to disk brakes. ♦



MetroLaser's VibroMet is a self-aligned, easy-to-use system for measuring surface vibrations that provide key information on the structural integrity and acoustical characteristics of manufactured products.